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A NUCLEAR ENERGY RENAISSANCE: CHALLENGES TO NUCLEAR WEAPON NONPROLIFERATION

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ABSTRACT

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The potential for explosive growth in the world's utilization of nuclear energy is looming on the horizon. Energy security and environmental concerns with burning fossil fuels are driving what could be the biggest expansion in nuclear power since the 1960's. This significant expansion, while beneficial to the world's societies, carries the risk of a rapid expansion in the number of nuclear weapon capable nations. This is a real threat to future U.S. security and poses challenges to U.S. and world nonproliferation efforts. A new initiative is needed to meet the emerging enrichment and reprocessing capabilities around the world. Three proposed approaches are discussed and analyzed. Recommendations for U.S. nonproliferation policies are made.

A NUCLEAR ENERGY RENAISSANCE: CHALLENGES TO NUCLEAR WEAPON NONPROLIFERATION

The Growth of Nuclear Energy

The potential for explosive growth in the world's utilization of nuclear energy is looming on the horizon. Twenty-two years after the Chernobyl nuclear reactor accident the world's nuclear energy industry is booming.[1] Nuclear energy is experiencing a strong revival around the world and in the United States. There are currently 439 nuclear reactors operating worldwide, in 30 countries. Thirty-five new plants are under construction in 14 countries. There are other proposals for another 223 new plants. Over thirty countries that do not currently possess nuclear power plants, are now considering building them.[2] The International Atomic Energy Agency (IAEA) has seen fit to publish a pamphlet to assist nations considering entering into the nuclear power industry.[3] In the U.S., power utilities have 22 new plants in various stages of development.[4] This is a particularly large shift in a country that hasn't started a new reactor since 1980. U.S. Presidential candidate, Senator John McCain, made the construction of 45 new nuclear power plants with a further goal of 100 a cornerstone of his energy policy.[5] If this nuclear renaissance continues to materialize over the next 10-20 years, it will have a significant and lasting strategic impact on nonproliferation efforts.

Several key main forces are driving this renewed interest in nuclear power. The first is energy security. Control of the much of the world's oil production rests primarily in the hands of a few (usually despotic) countries. The need for access to these reserves often forces poor choices on the U.S. and other western democracies. There are also legitimate concerns over the ability of fossil fuel supplies to even meet future

worldwide energy needs. Some analysts have stated that the worldwide Hubbert's Peak for oil has already been reached.[6] The skyrocketing cost of oil in 2008 sent shockwaves throughout much of the world's economy. A search for a solution has suddenly become high on the agenda for many governments. Many are now looking towards nuclear energy as a stable, long-term and secure answer. To be completely secure though, requires a nation to have full control of the entire nuclear fuel cycle. This is driving countries to pursue enrichment and reprocessing technology.

Although nuclear power cannot directly replace oil and its uses for transportation, it can directly replace the use of natural gas in electrical generation. This would also benefit a Europe which relies heavily on the natural gas pipelines from Russia. Recent disputes between Russia and the Ukraine have highlighted the insecure nature of this supply.[7] Nuclear power can also eventually replace oil for transportation by providing the energy necessary for two possible next generation modes of transportation: electrical or hydrogen powered vehicles. Electrical as increased demand on the power grid or hydrogen as produced either by electrolysis or through a high-temperature nuclear reactor.

As world demand for energy has increased, the demand for fossil fuels has subsequently increased along with their costs. The cost of nuclear energy can be very competitive. While the media often describes nuclear power as expensive, it is primarily the up-front costs that are high. In fact, the per kilowatt-hour production costs of nuclear energy produced electricity are the cheapest available (nuclear 1.76, coal 2.47, natural gas 6.78, petroleum 10.26 ¢/kW-hr in 2007) and is the only significant power source that

has dropped in cost over the past 10 years. Natural gas produced electricity, on the other hand, has nearly doubled in cost during the same period.[8]

The United States too is starting to recognize that a new era of nuclear power has the potential to meet a significant share of future energy needs. This recognition also sees that a new generation of nuclear power plants is necessary to meet any long term energy security. New reactor designs for proliferation resistance, efficiency and for possible production of hydrogen are needed. In response, the U.S. has teamed with nine other countries to form the Generation IV International Forum (GIF). To quote from the GIF's Technology Roadmap, "Many of the world's nations, both industrialized and developing, believe that a greater use of nuclear energy will be required if energy security is to be achieved."[9] Concurrently, the GIF recognizes the inherent proliferation concerns with expanding nuclear energy. One of the four technology goals for the Generation IV nuclear energy systems defined in the roadmap is expressly to "*develop proliferation resistance and physical protection*."

The second driver is the awareness of global warming and the contributions of burning fossil fuels to it. The environmental lobby, which for decades opposed nuclear power, has now to a significant part come to support it as an important answer to reduce carbon emissions. For example, Pat Moore, co-founder of Greenpeace, is now a proponent of nuclear power.[10] The U.S. currently produces over 70% of its electricity by burning fossil fuels, predominantly coal (49.9%) and natural gas (19.3%).[11] Fossil fuel fired plants all over the world discharge about 800 tons of carbon dioxide every second.[12] Nuclear energy is currently the only energy source capable of significant expansion to replace the many terawatts of power produced by burning fossil fuels. The

likely addition of carbon emission taxes and tax credits will only make nuclear power more economically attractive. In addition, if the goal is to replace gasoline automobiles with hydrogen fueled vehicles, the hydrogen must be produced somehow. The U.S. Department of Energy's Next Generation Nuclear Energy source is planned to be the Very High Temperature Reactor which is designed to specifically allow for the production of hydrogen as part of the operating cycle.

Several countries are looking at nuclear power as an answer to scarcity of another resource: potable water. The Gulf (Persian) Cooperation Council nations, Jordan, Egypt, Libya, and Morocco are all considering nuclear energy to power saltwater desalination facilities.[2]

In addition to energy security motives, good economics, and good environmental stewardship, there is an inevitable international status that comes with possessing a nuclear energy industry and ultimately nuclear weapons themselves. Dr. Barry O'Neill, Director of the U.S. Air Force Counterproliferation Center, in *Nuclear Weapons and National Prestige* writes, "Prestige-seeking can have the dangerous consequence of adding to states' motivation to build and test nuclear weapons."[13] The prestige factor can motivates both stable democratic states, like France and Australia, and despotic states, like Iraq.[14] The pursuit of proliferation in unfriendly countries, nations with poor internal security, and especially nations that sponsor terrorism is, of course, of particular concern to the United States.

Nations' pursuit of nuclear power may also be driven by legitimate regional security considerations. Of the 30 countries actively considering nuclear power programs, ten are in the Middle East. An overtly or even covertly nuclear armed Iran

could have a nuclear "domino effect" on the other countries in the Middle East. Nations such as Egypt and Saudi Arabia aren't necessarily interested in obtaining nuclear weapons, but may feel the need to position themselves to have the capability to rapidly develop nuclear weapons should the need to confront a nuclear-armed and regionally belligerent Iran. Both China, aggressively modernizing its nuclear arsenal, and North Korea could push either Japan or South Korea into deciding to initiate a weapons program.

These driving factors are legitimate and likely enduring reasons for nations to pursue nuclear power. While changes in conventional security concerns may obviate the need for a nuclear power industry as a base for a weapons program, the need for clean, secure, energy resources will only increase in the future. Whatever the ultimate driving force, a strong growth in worldwide nuclear power production seems very likely. The impact of this renaissance can be seen as a world-wide increase in *nuclear latency*. A marked and widespread increase in nuclear latency beyond the traditional nuclear nations will have a significant impact on the nonproliferation efforts.

Proliferation Risks Associated with Worldwide Nuclear latency

Nuclear latency is an ill-defined concept in the literature. (In fact, the entire literature of weapons of mass destruction suffers from ambiguity and imprecision. For example, Seth Carus of the Center for the Study of Weapons of Mass Destruction, National Defense University, has written an entire monograph discussing the various ways the term "weapons of mass destruction" is defined![15]) For purposes here, nuclear latency may be defined as a country's (or even an organization's) nuclear capacity and potential in terms of knowledge, technology and materials. Included are both nuclear

technologies for nuclear power and for nuclear weapons. The two sets of knowledge are too intimately linked to separate. In the scheme of the *ways*, *means* and *ends* of acquiring nuclear weapons, nuclear latency is the *ways* and *means*. This definition restricts the concept to include only the engineering and technical aspects. It represents the capability to proliferate.[16]

Of course capability is only half the story. A nation must also have the national will (even as solely embodied in the person of a dictator) to develop the weapons. A country's social, cultural, historical and political aspects will also have great bearing on whether it is a *weapon* proliferation risk or not. Japan is an excellent example of a country considered to have the highest level of nuclear latency. It possesses a robust nuclear power industry, complete command of the nuclear fuel cycle and has the engineering knowledge and industry to easily build a weapon. Japan refrains from developing nuclear weapons because of a combination of the non-technological aspects of proliferation. In a world with an ever increasing nuclear latency, it is only going to be through the non-technical factors that nonproliferation can be effective. The nonproliferation regime must fully understand why countries choose to forego the prestige, while others pursue it, and manipulate those factors to prevent proliferation.

A world characterized by a high nuclear latency poses a direct challenge to the entire nuclear nonproliferation regime. Nuclear latency is growing rapidly with as many as 35 to 40 countries currently possessing the ability, if not the will, to develop nuclear weapons. With nuclear knowledge, technology and materials more accessible today than at any other time, there is a great risk of an uncontrolled diffusion of latency to undesirable nations and transnational organizations.[17] Indeed, the idea of spreading

nuclear power without spreading nuclear proliferation concerns some the nation's most influential thinkers and policy makers.[18]

> "An additional arms race stability factor is posed by the rising nuclear latency of many states in the regional subsystems. This latency derives in part from the abandonment of weapons programs by a number of states, where the expertise presumably exists to reconstitute if necessary. It derives in part from the rising role of nuclear power generation in the global energy equation—especially in Asia. And it derives in part from the generally rising technical skill of developing countries. The number of states capable, from a purely technical point of view, of making nuclear weapons is far larger than the number actually doing so. Nearly 70 states operate nuclear power or research reactors, for example. Some of these latent capabilities are pursued at least in part as a hedge against some future collapse of a state's security environment. They are thus a form of reassurance to those who possess them—and of concern to their neighbors. The more concerned states are about the possible collapse of their security environment, the more advanced appears to be the hedge. This diffusion of latency through the international system points to the possibility of a future form of proliferation different from what we have so far seen. So far, we have experienced only the slow incremental addition of new nuclear states (as well as the occasional subtraction). The diffusion of latent capability makes possible a future wildfire-like proliferation as states rush to turn weapons capabilities into weapons in being in response to some catalytic event."[19]
>
> – Brad Roberts

Increased dissemination and diffusion of nuclear technology is extremely difficult to stop. The ability of even a single individual, such as A.Q. Khan[*], to successfully proliferate for extended periods of time, and the desire of the nuclear poor for knowledge and capability, makes a powerful and likely unstoppable combination.[20,21] U.S. Army strategy specifically addresses this as an influence on future conflict, "There is greater likelihood that more states will acquire WMD, including nuclear weapons,

[*] As head of Pakistan's nuclear weapons program, A.Q. Khan successfully ran an international proliferation network throughout the 1990's. The magnitude and extent of his network was a shock to western governments.

which will increase the risk of proliferation to non-state actors – either by deliberate state action or through loss of control."[22]

Although all aspects of nuclear latency ultimately contribute to proliferation risks, two areas are key: the abilities to enrich and reprocess nuclear fuel. A country that controls these aspects of the nuclear fuel cycle has essentially no further technical barriers to the development of weapons themselves. As discussed in more detail later, legitimate uses of these capabilities represents the weak technical link in the Nonproliferation Treaty.

Fissile materials are needed for both nuclear power and nuclear weapons. Fissile materials are materials whose nucleus will split when absorbing a slow (i.e. low energy) neutron. The split nucleus then emits additional neutrons. These additional neutrons can support a chain reaction by splitting other nuclei. The products of the split nucleus are also very energetic. In a nuclear reactor, the chain reaction is carefully controlled and the energy of the fission reaction is used to generate electricity, usually through heating water and use of a steam turbine generator. In a nuclear weapon, a conventional chemical explosive puts an amount of fissile material into a highly compressed supercritical state. The chain reaction then proceeds in a rapid, uncontrolled manner, releasing the vast energy of a nuclear explosion. (Reactor designs prohibit ever achieving a supercritical state, so it is impossible for a nuclear reactor to ever have a "nuclear" explosion.) Enrichment and reprocessing technologies produce the suitable fissile materials.

Enrichment is the ability to separate different isotopes of the same chemical element (isotopes have the same chemical makeup, but slightly different masses) and is

key for developing a uranium based weapon. For example, natural uranium ore is 99.3% isotope mass 238 (U^{238}) and 0.7% isotope mass 235 (U^{235}). For certain reactor designs and for all weapons, this percentage of U^{235} needs to be raised significantly higher through enrichment processes like gaseous diffusion, laser isotope separation or most commonly today, centrifuge cascade. Because the different isotopes are chemically identical (for most chemical processing at least), enrichment is difficult, expensive and time consuming. It has represented the single most important technical barrier to weapon proliferation. Control over the export/import of the technical equipment to achieve this enrichment is a keystone of the NPT.

Reprocessing is needed to develop a plutonium based weapon. When uranium fuel is burned in a reactor, some of the U^{238} absorbs a neutron and transmutes to plutonium isotope 239 (Pu^{239}). Reprocessing used reactor fuel is done to separate the plutonium from the other elements. Because plutonium also readily absorbs neutrons to form higher isotopes, a reactor that is frequently refueled is indicative of producing weapons grade plutonium. International Atomic Energy Agency (IAEA) safeguards on reactor operation and fueling is the key prevention of reprocessing spent fuel to obtain weapons grade plutonium.

Complicating both enrichment and reprocessing is the fact that they both have legitimate, useful purposes in a civilian nuclear power infrastructure. Light water reactors require enriched uranium to operate, albeit at much lower enrichment percentages. Reprocessed plutonium in mixed oxide fuels is also burned in reactors and is an excellent way to increase the overall operating efficiency of an advanced nuclear power infrastructure.

In the past, the United States and the nonproliferation regime relied strongly on the inherent technical barriers to prevent proliferation. Few countries had complete nuclear fuel cycles. Those that did were generally, with the notable exception of Pakistan, reliable and kept good security over their infrastructure. Many countries with nuclear power plants relied on others to provide the nuclear fuel. Keeping a watchdog on those few countries was sufficient to keep proliferation under control and to a minimum. Failures (India, Pakistan) could be seen as somewhat balanced by successes (Libya, South Africa). However, in a world with ever increasing nuclear latency, this approach is ever more risky. The technical barriers will be lower, the cost cheaper and the time frame shorter to achieve a nuclear weapon state. Under the obvious presumption that fewer nuclear-armed states are beneficial for U.S. and world security, U.S. nonproliferation efforts will be come even more important in the future. The U.S. can best achieve this objective by refocusing its nonproliferation efforts using a combination of old approaches and new ideas, adherence to the spirit of the NPT, and a renewed commitment to the IAEA.

Key Aspects of the Current Nuclear Nonproliferation Regime

The nuclear nonproliferation treaty (NPT) of 1968 is the most important, non-technical, barrier to nuclear weapon proliferation.[23] This treaty designated the U.S., U.S.S.R., U.K., France, and China as nuclear weapon states. All other signatories are called non-nuclear weapon states. Under Article I, nuclear weapon states agreed not to assist in developing, or transferring nuclear weapons to non-nuclear weapon states. Under Article II, non-nuclear weapon states agreed to neither manufacture nor seek to acquire nuclear weapons. Non-nuclear weapon states are allowed to pursue nuclear

energy for peaceful purposes. Importantly, nuclear weapon states also agreed to strive for the reduction and ultimate elimination of their nuclear arsenals. The treaty also established a system of safeguards to monitor compliance under the responsibility of the IAEA. 190 countries have signed the NPT with the notable exceptions of Israel, India, and Pakistan. Both Iran and the Democratic People's Republic of Korea (North Korea) are signatories; however, the DPRK withdrew in 2003.

Since under the treaty, non-nuclear weapon states are allowed to develop nuclear energy for peaceful purposes, a system of safeguards was established under Article III to control the international transfer of nuclear technology. Two international export control organizations have been established to monitor and control the export and import of nuclear technology. The Zangger Committee (NPT Exporters Committee) maintains a list of "trigger" items that require the implementation of Article III safeguards in order to be exported.[24] After India detonated a nuclear weapon in 1974, it was clear that nuclear technology transferred for peaceful purposes (the Bhabha reactor) could be misused to develop a weapon. In response, the Nuclear Suppliers Group was founded in 1974 and IAEA guidelines established to ensure that nuclear technology would not be diverted for non-peaceful purposes.[25] In 1992, these guidelines were expanded so that a non-nuclear weapon state had to accept IAEA safeguards on *all* its nuclear facilities ("full safeguards") to be allowed to import nuclear technology. Specifically, this effectively restricted any exports to Israel, Pakistan and India who are not signatories and do not accept full IAEA safeguards. As discussed later, this issue is at the crux of the controversy surrounding the recent U.S.-India 2008 nuclear agreement (United States-India Nuclear Cooperation Approval and Nonproliferation Enhancement Act[26]).

Implementation and control by the Nuclear Suppliers Group is maintained at the national level for each participant.

U.S. policy support for the NPT has seemingly been inconsistent and open to criticism from other nations. The presence of U.S. nuclear weapons in forward-deployed locations has been interpreted by some as a direct violation of Article I.[27] The recent U.S. – India Nuclear Agreement seems at odds with the 1992 expanded guidelines agreement. Both are cases where other priorities dictated policy. The first was a Cold War situation; the second is worthy of attention as a new agreement in the multi-polar environment of today.

India (a non-nuclear weapon state under the NPT) is an example of an NPT failure and the complications of nonproliferation along several lines. It has never signed the NPT. It circumvented international agreements to obtain nuclear technology and it used civilian nuclear technology to develop nuclear weapons. Under its agreements to the Nuclear Suppliers Group, the U.S. should prohibit all trade of restricted nuclear technology with India. However, in August 2005, the U.S. Department of Commerce announced that it was lifting many of the trade restrictions as part of a U.S.-India nuclear agreement.[28] The motivation for this agreement appears to be wholly economic and political to strengthen ties between the U.S. and India. This agreement drew open criticism from some and grumbling from other members of the Nuclear Suppliers Group.[29] The agreement does pledge India to clearly separate its civilian and military nuclear facilities, placing the civilian facilities under IAEA safeguards, work with the U.S. on the Fissile Material Cutoff Treaty (discussed later under the GNEP), maintain a test moratorium and refrain from transferring enrichment technologies. This bilateral

initiative represents a different path for the U.S. in nonproliferation. What long-term impact this agreement has on the NPT remains to be seen.

What is clear is that this bilateral agreement erodes the U.S. position in criticizing bilateral deals of other nations. Russia has been active in supporting Iran and its efforts. China has in the past supported Pakistani development. Both of these arrangements have been criticized by the U.S.

The case of Libya demonstrates attempts to circumvent the NPT, implementation of complete verification and compliance, and then successful export/import of nuclear technology under the NPT and IAEA safeguards. After the U.S. found evidence that Libya was secretly importing centrifuge technology through the A.Q. Khan network, Libya made the strategic decision to abandon its WMD programs with full elimination and verification. Once the U.S. was satisfied with Libya's actions, it rewarded Libya by funding a new regional nuclear medicine medical center.[30] The U.S. also established a sister laboratory agreement between Department of Energy laboratories (Los Alamos, Lawrence Livermore and Oak Ridge National Laboratories) with the Libyan Tajura Nuclear Research Center to explore civilian nuclear research.[31]

Intelligence Demands in the New Environment

An increased worldwide nuclear latency, with greater access - especially indigenous - to enrichment and reprocessing technology, will impose significant demands on the intelligence community. Any country with direct access to either technology will have to be considered as nuclear (in the weapon sense) capable; nuclear capable meaning the ability to build a weapon if the political will is present. The physics of weapon design is commonly available information. The easy availability of

dual-use technology means the engineering aspects of a weapon are not a barrier either. In almost any conceivable scenario, it is only the lack of fissile material that could be the technical roadblock to the ability to construct at least an unsophisticated weapon. Don't forget that Little Boy, developed in the mid-40's, was dropped on Hiroshima without even a test. Much of the surveillance technology relied upon by the U.S. IC would be irrelevant. Satellite imagery identifying a production facility, such as Iraq's Bashere reactor, would serve no purpose. The facility now has a peaceful, commercial "cover". Intelligence now would have a much more difficult task in identifying when fissile material is diverted from legitimate uses.

Indeed, it would also be manifestly more difficult to identify when a country transitions from nuclear capable, to being a nuclear threat. Unless a country wished to trumpet its nuclear capability through a test, as North Korea did, they could easily keep possession of nuclear weapons a secret, or at least unspecified. Israel is commonly believed to possess a significant number of weapons, but has never conducted a test. National technical means designed to detect a nuclear detonation cannot rule out possession of operational weapons, only confirm it. The difficulty presented to the U.S. intelligence community is that a high latency world erodes away their strongest attribute in technical data collection (e.g. MASINT). The extent and success of the A.Q. Khan network over a number of years illustrates the great difficulty facing intelligence agencies in identifying proliferation efforts.

Challenges to U.S. Policy

Understanding what would drive a nation to move from nuclear capable to nuclear threat is the key to the ability to develop strong nonproliferation incentives and to provide warning to decision makers.

Policy implications can be significant if it isn't clear a nation has moved from nuclear capable to a nuclear threat. Can U.S. policy continue to follow a pragmatic approach, treating friendly nations one way, and threats another, when there are potentially so many proliferation avenues ready to open. The issues and options available when the NPT was signed are vastly different than what is likely to be facing the U.S. in 10-20 years. National sovereignty and perceived (or real) discrimination between nuclear haves and have-nots significantly complicates all of the initiatives currently proposed to restrain access to enrichment and reprocessing technology.

Current U.S. policy on nonproliferation (and combating all weapons of mass destruction in general) under the Bush Administration is characterized by a multilateral approach. The U.S. State Department calls this approach "effective multilateralism."[32] Ambassador Robert Joseph, Under Secretary of State for Arms Control and International Security, stated in 2006 that, "We recognize that stopping and reversing proliferation involves affecting not just the capabilities, but also the intentions, of proliferators."[33]

Iran exemplifies the future challenges in nonproliferation. In the past couple of years, there has been a spate of articles addressing the ways the United States can deter a nuclear armed Iran.[34,35] A nuclear armed Iran would be a significant failure of nonproliferation efforts. A nuclear Iran also represents a potential crumbling point in a scheme that has worked for over 50 years. A significant aid to nonproliferation efforts

has been the U.S. nuclear umbrella. Countries such as Japan have been assured of a U.S. nuclear security guarantee for decades. These assurances have done a great deal to remove the "will" for nations, such as Japan, to develop weapons. The options for the U.S. with a nuclear Iran are limited. It would be very problematic for the U.S. to extend its nuclear umbrella throughout the Middle East.

A multilateralism approach implicitly means a select set of nations, not a global international program. This approach can only be effective to "turn back the clock" on a weapons state. A group of powerful countries, such as the six-party group with N. Korea, can exert enough influence to coerce and induce disarmament. It is fraught with danger as an approach to nonproliferation. The cracks that are straining the NSG are evidence. Bilateral agreements between the U.S. and India, China and Pakistan, and the desire of individual nations such as Canada and Brazil to sell enrichment technology are seriously damaging the technical controls implemented in the NPT. A multilateral approach leaves too many options for determined proliferators.

If the potential nuclear renaissance unfolds as predicted, the nonproliferation regime cannot accept a worldwide increase in nuclear latency that includes easy access to either enrichment technology or reprocessing technology. These key enabling technologies are too vital a link in the development of nuclear weapons.

Without a viable solution to worldwide access to enrichment and reprocessing, nations outside the mainstream international community, such as North Korea, can easily use the threat of developing nuclear weapons to extort economic or political leverage where it normally would have none. Libya is reaping financial rewards today for abandoning its nuclear weapon program. North Korea has waffled back and forth.

Nuclear weapons are North Korea's only products. It has to sell them anew each year. N. Korea can agree to stop weapon production in exchange for concessions or aid. A year or two later, it can simply start up, or threaten to start up, a weapons program again unless granted further concessions and aid.

Approaches

The U.S., Russia and the IAEA have suggested three different approaches to meet the fuel needs of a vibrant nuclear power industry while simultaneously restricting access to weapons grade materials. Each of these approaches harkens back to some extent the Baruch Plan originally proposed by the U.S. in 1946.[†36] Each approach has political and technological challenges.

President Bush in a February 2004 speech at the National Defense University targeted the key loop-hole in the NPT calling for the creation of an international safe, reliable, nuclear fuel supply system for civilian power reactors. Closing the loop-hole so that, "Enrichment and reprocessing are not necessary for nations seeking harness nuclear energy for peaceful purposes."[37] This statement was eventually embodied in the Department of Energy's GNEP program.

The Global Nuclear Energy Program (GNEP[38]) is a U.S. Department of Energy initiative started in 2006 to bring together nations that understand the importance of

[†] Under the Baruch Plan the Atomic Development Authority would oversee the development and use of atomic energy, manage any nuclear installation with the ability to produce nuclear weapons, and inspect any nuclear facility conducting research for peaceful purposes. The plan also prohibited the illegal possession of an atomic bomb, the seizure of facilities administered by the Atomic Development Authority, and punished violators who interfered with inspections. The Atomic Development Authority would answer only to the Security Council, which was charged with punishing those nations that violated the terms of the plan by imposing sanctions. Most importantly, the Baruch Plan would have stripped all members of the United Nations Security Council of their veto power concerning the issue of United Nations sanctions against nations that engaged in prohibited activities. Once the plan was fully implemented, the United States was to begin the process of destroying its nuclear arsenal.

expanding nuclear energy for peaceful purposes in a safe and secure manner. It is attempting to accelerate the development of an advanced fuel cycle that would significantly reduce the risk of proliferation. The GNEP currently has 21 member nations including the U.S., Russia, China, Japan and France. The GNEP is an attempt to address what is understood as the weak link in the NPT – Article IV and the right of non-weapon states to develop civilian power programs. As discussed earlier, India used this loophole to develop its weapons program.

The GNEP effort is largely a technical approach to the proliferation problem. The Statement of Principles issued September 16, 2007, identifies several technical objectives designed at reducing proliferation, such as fast reactor technology for burning transuranics and advanced fuel cycles that do not require separation of plutonium. Even with successful development of these technologies, Paul Bernstein, Vice President, SAIC, argues that it may be difficult to obtain many countries' acquiescence in giving up their sovereign rights over their own nuclear fuel cycle.[39] Other writers note that "In a future nuclear system, technical barriers alone cannot prevent countries from obtaining nuclear-explosive materials and eventually nuclear weapons."[40]

Dr. Mohamed El Baradei, Director General of the IAEA, has proposed a three part solution. His proposal harkens back strongly to the Baruch plan first by placing all the processing of weapons usable materials under *exclusively* international control. This includes the creation of an international low enriched uranium fuel bank. The second is to utilize proliferation resistant nuclear power systems. Lastly, to implement a multinational program to manage the storage and disposal of radioactive wastes.[41] The Nuclear Threat Initiative committed $50M in 2006 to jump-start this approach contingent

upon additional donations of $100M.[42] As of 7 Aug 2008, the IAEA had pledges of $65M from the U.S. ($50M), the U.A.E. ($10M) and Norway ($5M).[43] The IAEA has had to request a one-year extension to meet the $100M deadline.

Concerns over Russian sales of nuclear technology to Iran prompted Russian President Vladimir Putin to suggest building a network of international fuel cycle centers operating under IAEA safeguards. As a first step, an international uranium enrichment center (IUEC) was established, out of existing facilities, at Angarsk, Russia. The IUEC would only enrich uranium and would not accept spent fuel. Originally conceived to abrogate any enriching needs for developing nuclear countries, the idea has now grown to include countries with limited enrichment capabilities. Steps that have been taken put the IUEC on an international footing by establishing an open joint-stock venture, an external (to Russia) management board and participation from Armenia, Mongolia, Kazakhstan, South Korea, Ukraine and Uzbekistan.[44]

The question is whether any of these three ideas can work in practice. The fact that there are three similar efforts underway surely means that they must either converge together in some fashion or separately fail.

There exists a haves and have-nots world order with respect to nuclear weapons. In the 40 years since the NPT was signed, progress towards eliminating nuclear weapons from all countries (as required by Article VI) has been sporadic at best and a rapid arms race at worst. The nuclear weapon states do not have the moral high ground to convince a non-weapon state to not pursue proliferation if it is in their self-interest. The discrimination is self-evident. This hypocritical situation nullifies the validity of much rational argument. What is left is coercion.

The nuclear weapon states, usually led by the U.S. and NATO Allies, have used a combination of positive and negative coercion over the past 40 years to restrict proliferation. Economic sanctions, embargoes, and export controls along side military aid, extension of "nuclear umbrellas" and other security guarantees have been moderately successfully in limiting proliferation. Unfortunately, the successes, like Libya, are rare and the failures, like India, are permanent (with the notable exception of South Africa).

The three proposed fuel cycle approaches significantly raise the positive coercion factor. Each in its way will ensure the reliable availability of quality nuclear fuels. Countries will be freed from the very substantial costs and technical challenges of deploying their own enrichment and reprocessing systems. This would be a time saver in establishing a native nuclear power industry as well. The GNEP and El Baradei proposals feature the added advantages of assistance with (proliferation resistant) nuclear technology. This technology would be significantly more difficult and expensive for countries to obtain independently. The El Baradei plan also includes proposals for an international waste management system.

The GNEP and El Baradei approaches offer very good assurances that *participating* nations will not be proliferators. Strong safeguards, control of enrichment and reprocessing facilities and proliferation resistant reactor designs will make the "India route" very difficult to achieve. As Feiveson, Glaser, Miller and Scheinman noted, technical barriers alone cannot prevent a nation from obtaining nuclear weapon material.[45] Still, the easier path for a proliferating nation would be to opt out of an international system with strong controls and proliferation resistant technology. Even

this path would be more difficult with either proposed international system in place. If the large majority of nations are participants, then the isolated few outside the norm would be easier to monitor and safeguard exports. Of course, it is always possible for a country to use its indigenous resources to develop a weapon on its own. This would, however, greatly increase the difficulty, time and cost providing additional opportunities for the international community to take further action.

In all three plans, the negative coercion factor is largely missing. Since both the GNEP and the IUEC plans originate from nuclear state countries, there will be a significant stigma to any negative coercive efforts originating from these plans. The haves keeping the have-nots down. This is an extremely important issue when considering the international prestige factor. The El Baradei proposal also does not spell out a specific framework for negative coercion. However, it does suggest that the new framework should be the "'peremptory norm' of international law – not vulnerable to any nation subsequently withdrawing."[46] Adding to its moral authority, it calls for the implementation of the Fissile Material Cut-off Treaty and for an agreement on nuclear disarmament on an agreed timetable. While a nuclear disarmament agreement is not likely achievable any time soon, a reinvigorated disarmament process and an agreement to disarm in principle is. The El Baradei proposal could then simultaneously be implemented with a framework with strong negative coercion aspects. While the United Nations does not go to war with its members, a united international community with the proper moral authority would have the economic, industrial and diplomatic strength to impose severe punishment on a nation that chooses to go it alone and develop nuclear weapons.

If the impending nuclear renaissance occurs, the IAEA will be severely pressed financially and organizationally to meet the safeguard requirements in so many locations. Not one of the three fuel cycle proposals can be effective without strong monitoring in place. The more sophisticated nuclear systems will undoubtedly raise the difficulty bar for subverting a civilian power system. However, determined proliferators will still be able to gain access to plutonium by circumventing IAEA safeguards. The further piece of the nonproliferation effort is to eliminate the "determined" aspect from a country. A strong combination of positive and negative coercion has the best chance at eliminating "determined."

The United States should work with the IAEA to bring both the GNEP program and the IUEC program into the El Baradei proposal. This will markedly strengthen the capability of the IAEA. The two programs will provide the strong technical and facility basis to get the El Baradei program off to a strong start. Any success the GNEP or IUEC would hope to achieve would require a strong IAEA in any case. The El Baradei plan greatly strengthens the tools available to the IAEA. The moral authority granted to the IAEA effort is not to be taken lightly. In order for unified international action to be successful, the support of the various national populaces is necessary.

A certain key aspect to this effort is the active participation of China. Often the object of U.S. criticism for proliferation activities, China has markedly improved its agreements and efforts since the early 2000's. China acceded to the NPT in 1992, joined the Zangger committee in 1997, and the NSG in 2004.[47] Principal Deputy Assistant Secretary of State for International Security and Nonproliferation Patricia McNerney acknowledged that this change has occurred in part because, ''[t]he

Government of China has come to recognize that it has a fundamental security interest in becoming a responsible nonproliferation partner."[48] China's participation is essential. Still, China's efforts have a long way to go. As an example, China's cooperation with Iran has aided Iran's nuclear efforts and watered-down U.S. efforts at sanctions.[49] The U.S. and its allies must make the case to China that active and full cooperation on nonproliferation is more important than any economic or regional security issue.

The U.S. has several tools it could bring to bear to influence China to become fully engaged in nonproliferation activities. As its largest trading partner, the U.S. has economic power it can exert through potential trade protectionist measures. The recent scandal with Chinese made goods (lead in children's toys, poisons in pet foods) provides a politically palatable opportunity to push this avenue. Chinese foreign and military policy is also continually focused on Taiwan. This is a diplomatic area of leverage the U.S. can utilize. A contained, non-nuclear Iran has to be judged worth more to U.S. security than the U.S. commitment to Taiwan. Full Chinese commitment to a strengthened and unified El Baradei plan would have to be seen as a milestone for further progress.

Commitment to the IAEA will begin with funds. The IAEA 2009 regular budget is $420M (of which safeguards and verification is $166M).[50] The IAEA has operated under a "zero-growth" budgetary guidance for several years. The U.S. contribution was $132M in FY07, $137M in FY08, and $137M in FY09. An independent commission called the IAEA an "extraordinary bargain" and called for a real increase of $50M a year for several years.[51] The IAEA cannot be expected to continue to achieve its objectives

while underfunded and amidst a significant increase in requirements. The U.S. needs to lead in increasing its contributions and influencing other nations to follow suit.

Conclusion

There are strong indicators that the nuclear power industry is poised for strong growth throughout the world. The potential exists for many new countries to enter into the nuclear power community. Many of these new countries are located in areas of the world with significant regional security issues. This has raised concerns over domino effects in nuclear proliferation in regional areas such as the Middle East and in the Far East. Unstable governments or countries with terrorist movements also raise the specter of nuclear weapon material ending up in the hands of transnational organizations.

The weak link in a nonproliferation regime for a world characterized by a high level nuclear latency is the access to enrichment and reprocessing technology. Diversions from steps in the fuel cycle pose the greatest risk to the development of weapons in undesirable countries. The three international proposals led be the U.S., Russia and the IAEA hope to greatly reduce the diversionary loop-hole in the NPT.

The surest way to prevent proliferation out of regional security concerns is to at least maintain the status quo and prevent any new regional powers from arising. Security assurances that no new nuclear weapon states will be tolerated by the international community are essential.

Last of all, the nuclear weapon states, led by the U.S., Russia and China, need to vigorously work towards the reduction and elimination of nuclear weapons. As long as the international community tolerates nuclear weapons in the hands of some nations, it

loses the moral authority to prevent others. Then it is reduced to an equation of forcible coercion or inducement. In the new globalized, multi-polar world, the ability of a single nation to effectively coerce another country is greatly diminished. The multinational approach used by the U.S. in effecting change in North Korea (hopefully) demonstrates the necessity of establishing much stronger international accords and organizations to deal with the possibility of many new countries entering the nuclear community.

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